We will discuss how to easily and quickly calculate various types CRI's for your patients, then we will go over how to implement these for your patients using medications that you may already have on hand. The goal of this lecture is to give you the skills to enable you to calculate a CRI to improve the anesthetic safety and efficacy for your patients.

Included in your handout are all the drug dosages that we typically use, so don't feel the need to scribble madly while you're trying to pay attention to these slides.

CRI's can be used for many functions: management of pain control, blood pressure, GI supplements, insulin, nutrition, electrolytes or anesthesia. A CRI allows more accurate administration of drug over time and can be quickly changed based on the clinical effect.

You do not need specialized equipment to run a CRI, just IV access and fluids. An IV fluid pump is strongly recommended. Syringe pumps are handy and can help if you are using multiple CRIs on a single patient. A lower cost option would be use of a burette with your IV fluid pump, this is handy for smaller patients that are using decreased amounts of medications. These are about $3 each on Covetrus atm.

There are many ways to do the calculations. You will need the following info:

- The weight
- The dose
- The concentration (of the drug)

I personally find it easier to make sure that everything is calculated to mL/hr. This consistency allows me to be more confident in my calculations, since I have an idea of "does this sound right to you"? And fluid pumps usually run in ml/hr, so its easier to not have to do extra math every time I hook one up.

So now: the question you need to know is- what medication am I adding and why? This will determine how you do your calculation- will this medication stay at a constant rate? (ie: reglan) or will I need to change the rate before/during/after surgery? (ie: lidocaine, ketamine), or does this medication need to be titratable (dexmedetomidine, fentanyl)?

Don't do this. Ouch. Ok so here's my super-secret, non-patented trick: all I want to know is- how much medication will I need in an hour? From there it's eazy peezy lemon squeezy.

To calculate a drug that will be added to fluids running at a set rate, you will need to know:
The patient's weight
The dose
The concentration of the drug
This is the last bit, which can be quite variable: How are we delivering this medication? Most of us are familiar and comfortable with ml/hr, so lets make our calculations to be in ml/hr.
So, what is The hourly fluid rate?

For me, this last one is crucial. Imagine it this way:
Here is your LRS bag. **How many hours will it last?**

Get out those phones, folks, time to play along.

Dolly is a 15 kg Frenchie that needs a Reglan CRI at 2 mg/kg/day. Reglan is 5 mg/mL. So:

- 15 kg x 2 mg = 30 mg/day.

For a DAY.

How many mg in an HOUR?

- 30 mg divided by 24 hrs = 1.25 mg/hr
- 1.25 mg divided by 5 mg/mL = 0.25 ml/HOUR

So each HOUR, she needs 0.25ml of Reglan.

Hey Doc, what is her fluid rate? Your Dr tells you that her rate is 40ml/hr.

Now, how many HOURS will her fluid bag last? She has a 500 ml bag of LRS.

- 500ml LRS divided by 40 ml/hr = 12.5 HOURS.
- Each HOUR she needs 0.25cc of Reglan.
- 0.25 mg x 12.5 HOURS 3.1 mls of Reglan.

So you would remove 3.1 mls of LRS, and add in 3.1 mls of Reglan.

What if Dolly has already been on fluids all morning, and now you're adding Reglan to her remaining fluids? You just need to know how much is LEFT in the bag, and redo the number of hours:

- 15 kg x 2 mg = 30 mg/day.
- 30 mg divided by 24 hrs = 1.25 mg/hr
- 1.25 mg divided by 5 mg/mL = 0.25 cc/HOUR

Her bag now has 420 mLs of LRS left.

- 420 cc divided by 40 ml/hr = 10.5 HOURS.
- 0.25 ml x 10.5 HOURS = 2.6 mls of Reglan will be added to her bag.

Lets try another one:

Ellie is having abdominal surgery, and will get Lidocaine perioperatively to help w her pain control.

- She weighs 30 kg.
- Her Lido dose is 2 mg/kg/hr.
- Lido is 2%, which is 20 mg/ml.
- Her fluid rate will be 150 cc/hr during surgery.
- She will get a 500cc bag of fluids.

How much Lido do you add to her bag? Whip out those calculators, here we go!

- My dog: 30 kg times 2 mg/kg/hr = 60 mg/hr. Each hour, she needs Lido 60 mg.
- My Fluids: 500cc divided by 150 cc/hr = **My bag will last 3.33 hrs**
- My Meds: 60 mg times 3.33 hrs = 199.8 mg/bag.
    - Lido is 20 mg/ml. 199.8 divided by 20 mg/ml = 9.99 cc/bag.

Max is a 45 kg Shepherd that needs a Fentanyl CRI @ 2-5 mcg/kg/hr.

1. Convert mg into mcg: 0.05 mg/ml x 1000 = 50 mcg/ml
2. 45 kg x 2 mcg/kg/hr = 90 mcg/hr; 45 kg x 5 mcg/hr = 225 mcg/hr
3. 90 mcg/hr ÷ 50 mcg/ml = 1.8 ml/hr; 225 mcg/hr ÷ 50 mcg/ml = 4.5 ml/hr

(shortcut: Adding Fentanyl 20ml to a Liter bag of fluids will = Fent 1 mcg/ml which makes for easy math. Also, if your pt weight is in KG, move the decimal point one number to the LEFT, and the fent rate ON A SYRINGE PUMP will = out to 5 mcg/kg/hr.)

Frankie is a 10 kg Yorkie who needs Dopamine @ 2.5 to 10 mcg/kg/min. Dopamine is 40 mcg/ml.

1. Convert mg to mcg: 40 mg/ml x 1000 = 40,000mcg/ml
2. 10 kg x 2.5 mcg/kg/min= 25 mcg/min; 10 kg x 10 mcg 100 mcg/min
3. 25 mcg x 60 MINUTES = 1500 mcg/hr; 100 mcg/min x 60 min = 6000 mcg/hr
4. 1500 mcg/hr ÷ 40,000mcg/ml = 0.037 ml/hr; 6000mcg/hr ÷ 40,000 = 0.15 ml/hr

There are many options for adding analgesic CRIs into your anesthetic regimen.

OPIOIDS Potent and Safe. For moderate to severe pain. mild sedation in dogs, Cats: can cause excitement, dysphoria, hyperthermia. Be prepared w a sedative and to monitor Temp post op. Fully reversable (Naloxone- low dose? Short acting. Torb reversal?) Opioids require a loading dose before starting an opioid CRI. If the patient has already received an opioid "premed" (ie: Methadone, Hydromorphone), you will not need another loading dose before beginning a Fentanyl (or other opioid) CRI.

LIDOCAINE is a useful and inexpensive analgesic with anti-inflammatory and antiarrhythmic properties. useful for GI reperfusion injuries (GDV). Not for cats. Lidocaine also requires a loading dose to reach therapeutic blood levels before starting a Lido CRI. 3rd DO NOT GIVE with 3rd Degree heart block

KETAMINE is another inexpensive and common analgesic that helps to prevent "wind up pain". While it is ineffective as a single analgesic, it works very well in combination with an opioid CRI. Ketamine also requires a loading dose to reach therapeutic blood levels before starting a Ket CRI. This bolus can be included in the induction phase of anesthesia. Caution in patients with heart disease, CNS disease, head trauma.

ALPHA2 AGONISTS provide the benefit of sedation and analgesia. These medications are also fully reversable and are also ineffective as a single analgesic. A loading dose is not typically required before starting a CRI. Only for use in healthy, stable patients: causes profound cardiovascular changes